Safe Client Behaviour

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2 Billion

monthly active Android devices

Source: Google announcement, May 2017
2 ... 20 ... 200? servers in your cloud service?
clients » servers
Safe client behaviour = “do not DDoS”
Which requests are potentially unsafe?
What’s the worst that can happen?
What’s the best that can happen?
Ideal server-side request pattern
Rules for safe clients
Rule 1: Jitter Everything!
jitter /ˈdʒɪtə/ n. 
the deviation from true periodicity of a presumably periodic signal.
jitter /ˈdʒɪtə/ v.
add randomness to the periodicity of a periodic signal.
Worst case: Synchronized startup, no jitter.

```
period = 300  // Once every 5 minutes

while true:
    send_rpc()
    wait(period)
```
Worst case: Synchronized startup, no jitter.
Injecting jitter: Randomly change the periodicity.

```python
period = 300  # Once every 5 minutes

while True:
    send_rpc()
    wait(period * random(.5, 1.5))
```
Synchronized startup, jitter on future attempts
Ideal case: Startup jittered, future attempts jittered.

```
period = 300  // Once every 5 minutes

wait(period * random(.5, 1.5))

while true:
    send_rpc()

wait(period * random(.5, 1.5))
```
Ideal case: Startup jittered, future attempts jittered.
Startup oscillations from jitter.
while true:

    period = 300  # Once every 5 minutes

    next_execution = now()

    next_execution = truncate(next_execution, period)

    next_execution += random(1.0, 2.0) * period

    wait_until(next_execution)

    send_rpc()
Jittering without startup oscillations: Jitter execution time, not period.
while true:

    period = 300  // Once every 5 minutes

    next_execution = now()

    next_execution += random(1.0, 2.0) * period

    next_execution = truncate(next_execution, period)

    wait_until(next_execution)

    send_rpc()
Jittering without startup oscillations: Introducing synchronization by mistake.
Rule 2: Don’t Retry!*  

* Terms and conditions apply.
Fixed retry period, no jitter.

```python
while true:
    period = 300; delay = 10
    success = send_rpc()
    while not success:
        wait(delay)
        success = send_rpc()
    wait(period)
```
Fixed Retry Period, no jitter: Request spike and inadvertent synchronization
Fixed retry period with jitter.

```python
while true:
    period = 300; delay = 10
    success = send.rpc()
    while not success:
        wait(delay)
        success = send.rpc()
    wait(period * random(.5, 1.5))
```
Fixed retry period with jitter: No inadvertent synchronization
Jittered retry period, periodicity not jittered.

```python
while true:
    period = 300; delay = 10
    success = send_rpc()
    while not success:
        wait(delay * random(.5, 1.5))
        success = send_rpc()
    wait(period * random(.5, 1.5))
```
Jittered retry period, periodicity not jittered: Request spikes remain.
Rule 3: If you retry, back off!
Fixed retry period revisited: Sharp rise in request rate!
Retry with exponential back-off.

```python
while True:
    period = 300; delay = 10
    success = send_rpc()

    while not success:
        wait(delay)
        success = send_rpc()

    delay = delay * 2
    wait(period * random(.5, 1.5))
```
Exponential back-off to limit request spikes.
Retry with exponential back-off and jitter.

```python
while true:
    period = 300; delay = 10
    success = send_rpc()
    while not success:
        wait(delay * random(.5, 1.5))
        success = send_rpc()
        delay = delay * 2
    wait(period * random(.5, 1.5))
```
Exponential back-off with jitter: Smoother back-off
Retry with exponential back-off and jitter; retries capped.

```python
while true:
    period = 300; delay = 10

    success = send_rpc()

    while not success && delay <= period:
        wait(delay * random(.5, 1.5))

        success = send_rpc()

    delay = delay * 2

    wait(period * random(.5, 1.5))
```
Retry with exponential back-off and jitter; retries capped.
Retries: Terms and Conditions

- Don’t retry by default.
- Back off exponentially on retries.
- Jitter retries.
- Retry on specific error conditions:
  - Don’t retry on client errors (HTTP 400 errors.)
  - Do retry on server errors (HTTP 500 errors.)
  - Do retry on network errors.
  - Do retry (carefully) on timeouts.
  - Don’t retry on out of quota!
Effects of partial failures
while true:

    period = 300; delay = 10

    success = send_rpc()

    while not success:
        wait(delay)
        success = send_rpc()

    wait(period)
25% failures with exponential back-off: Error rate subsides, occasional error spikes.

```python
while true:
    period = 300; delay = 10
    success = send_rpc()

while not success:
    wait(delay)
    success = send_rpc()
    delay = delay * 2

wait(period * random(.5, 1.5))
```
while true:

    period = 300; delay = 10

    success = send_rpc()

    while not success:
        wait(delay * random(.5, 1.5))
        success = send_rpc()
        delay = delay * 2
    wait(period * random(.5, 1.5))
Safer clients: Move control to the server!

Implement Retry-After header in client and server.

Make sure to jitter retry periods on the server side.

Remote configure your clients!

Configure periodicity remotely.

Maintain a remotely configured client feature blacklist.
Safer clients: Expose information to server

- More information at server = more granular responses
- Tag requests with
  - Client name and version
  - Feature that triggered the request
  - Severity of failing the request
  - Retry or initial request?
- Possible server responses:
  - Prioritize interactive requests
  - Drop background requests
  - Avoid dropping requests known to trigger a retry storm
  - Work around client bugs
Safer Microservices
Safer microservices: Retry budgets

Limit retries to a percentage of total outgoing requests

Example: Only 10% of outgoing requests can be retries.

Prevents retries from completely crowding out legitimate requests.
Safer microservices: Adaptive Throttling

Reject new requests locally (at the client) based on rejection probability.

Reduces load on the server for rejected requests.

See https://landing.google.com/sre/book/chapters/handling-overload.html
Summary
1. Jitter everything!
2. Don’t retry!
3. If you retry, back off!
4. Move control to the server.
5. Expose info to the server.
6. Use retry budgets.
7. Use adaptive throttling.
Q&A

See also https://landing.google.com/sre/book/chapters/handling-overload.html